LRO Targeting of the South Pole-Aitken Basin for the Extended Science Mission

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Background

- For Exploration phase of LRO's mission, NASA designated nine Constellation sites within and associated with SPA as high-priority imaging targets.
- These sites have been intensely covered with Narrow Angle Camera (NAC) imaging, including images suitable for derivation of geometric stereo.
- Sites include:

SPA Interior	SPA Rim (TC)	Apollo Basin
Van de Graaff	Mare Ingenii	Schrödinger Basin

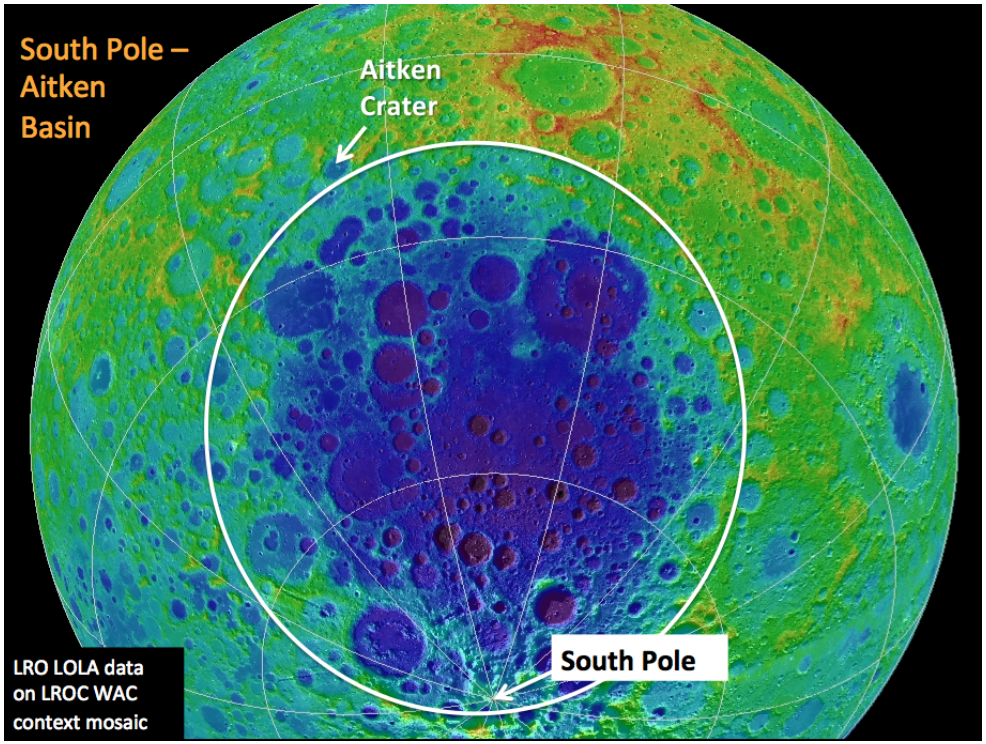
- In addition to these, sites on or near the rim include:

Aitken Crater	South Pole	Malapert Massif

- These sites encompass numerous high-priority science objectives articulated in the NRC SCEM Report and the Decadal Survey.
- ***Extended Science Mission orbit is ideal for southern hemisphere imaging, including images for high-resolution geometric stereo analysis.***

South Pole-Aitken Basin

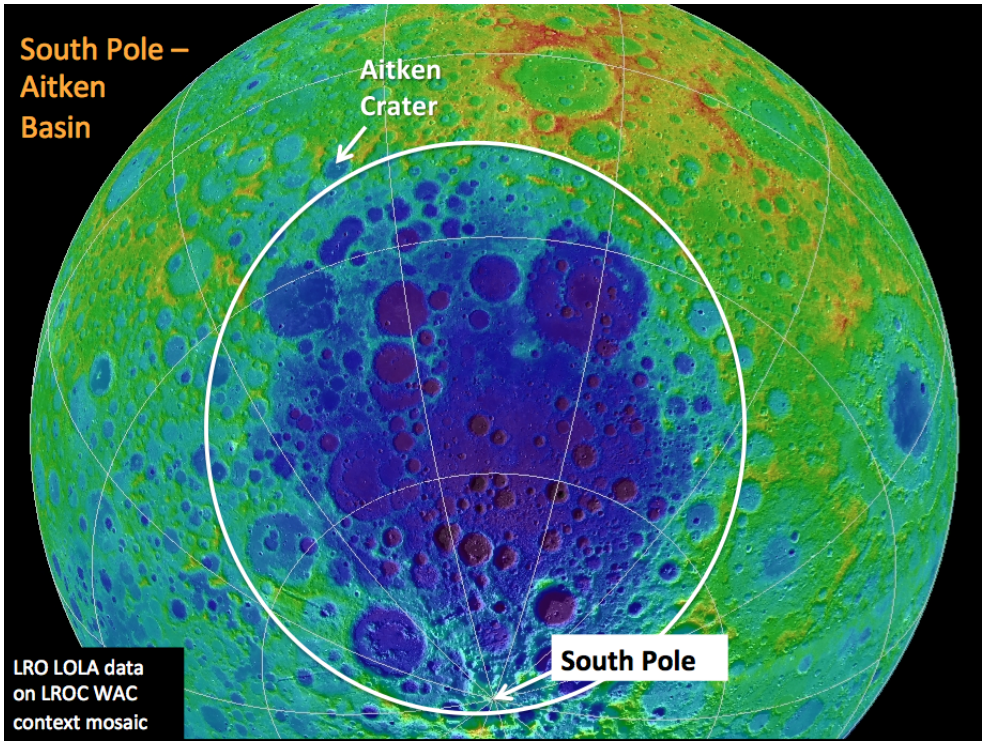
- **One of the richest scientific targets on the Moon**
  - Major unsampled "terrane"
  - What are the materials of the lower crust and upper mantle of the Moon?
  - How did the Moon differentiate?
  - Does Moon record an early "cataclysmic" bombardment within the Solar System?



Identified as a high priority for Solar System Exploration by the 2003 & 2012 NRC Decadal Surveys

Major Science Questions

- **SPA Giant Impact**
  - How deep did the SPA impact excavate? Hundreds of km?
  - What were the impact parameters (size, velocity, angle?)
  - What is the composition of SPA impact melt?
  - What are the clast contents?
  - Did the impact-melt complex differentiate?



What was the role of SPA in the early establishment of the Moon's megaregolith and its composition?

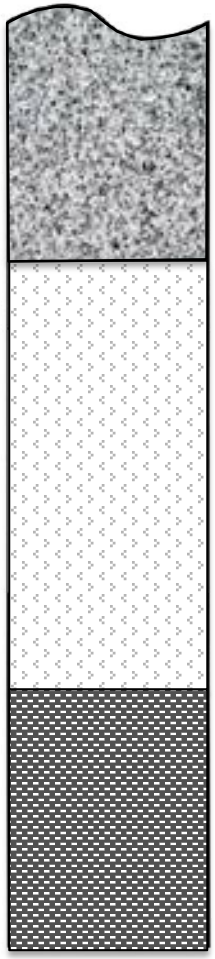
Role of SPA in Early Crust

What was the role of SPA in establishing early lunar upper-crustal deposits?

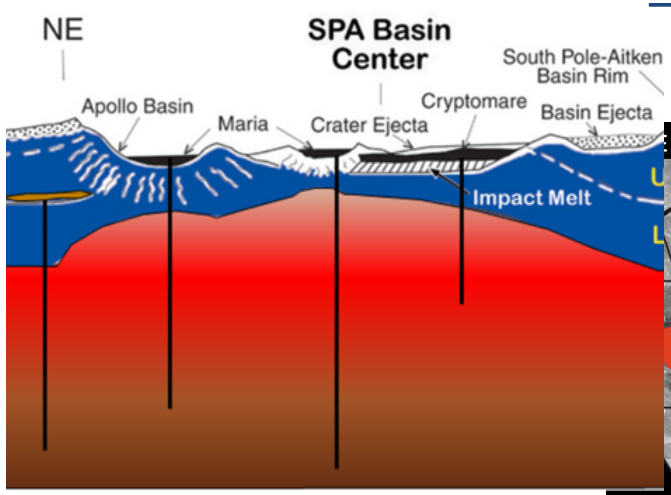
Remote sensing data imply anorthosite buried beneath a more mafic surface layer, suggesting gross layering as shown in the figure.

Why is anorthosite in the middle and not on top?

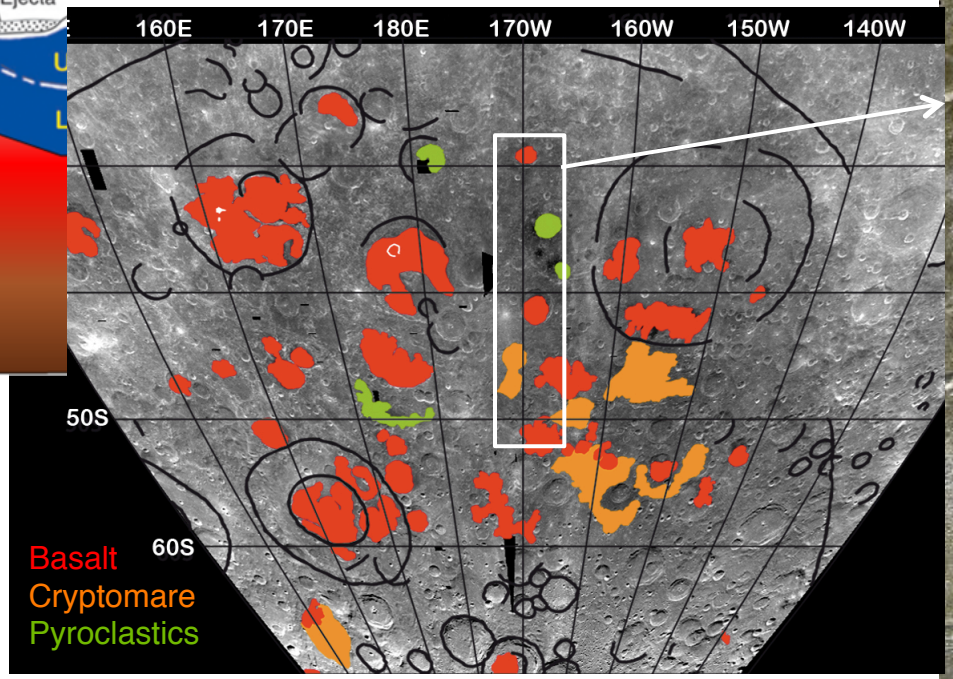
A deep mega-regolith developed from early era of basin impact ejecta accumulation – perhaps dominated by SPA ejecta.

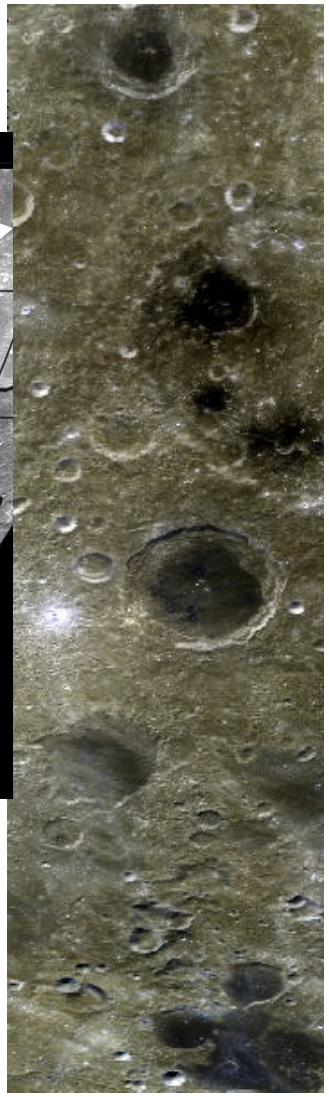


Farside Basalts



- How do far-side basalts differ from those sampled on the near side?





- How do far-side mantle sources differ from near side?
- What are the implications for global asymmetry?
- Direct information on far-side mantle beneath SPA Basin.

Thorium Distribution

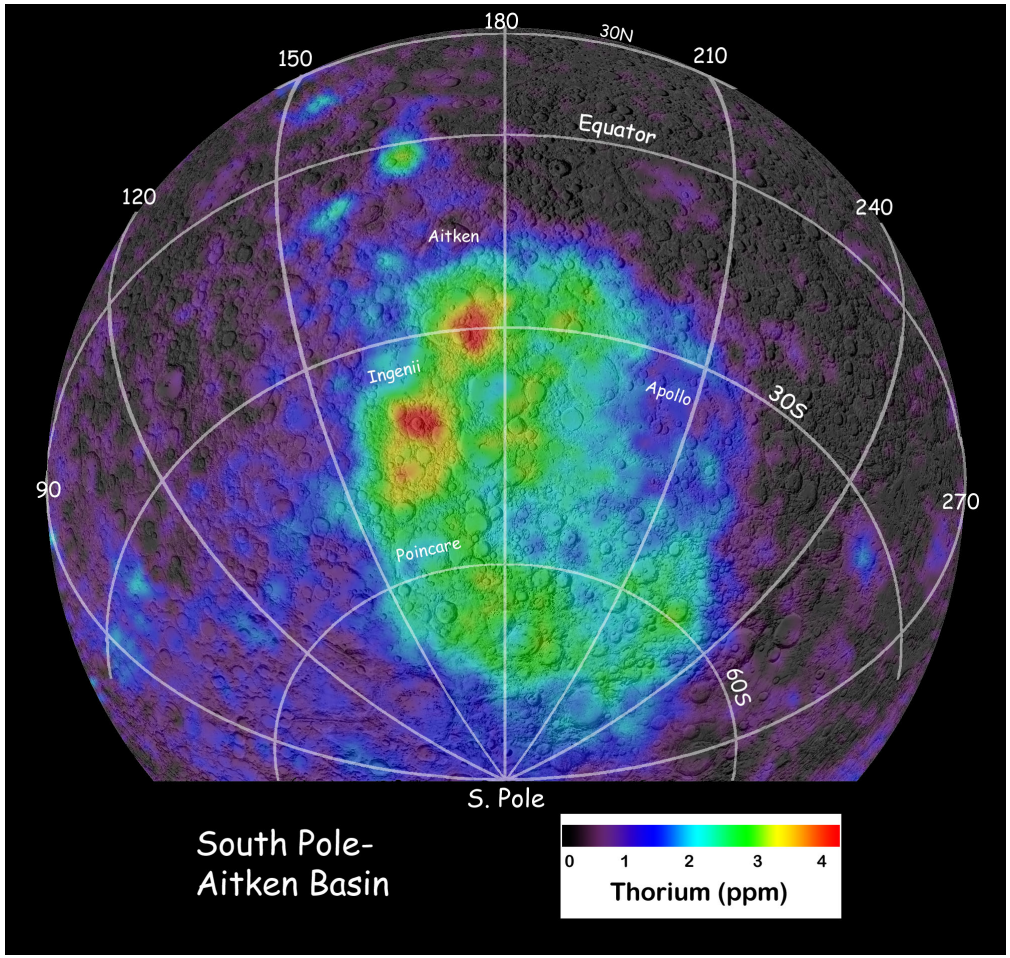
What is the cause of the "background" thorium content?

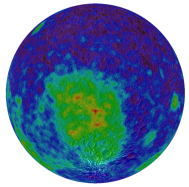
- Does it represent the Moon's lower crust?
- Does it represent an integration of lower crust and upper mantle?

What is the cause of the two anomalies?

- Oresme V Crater
- Birkeland Crater

What are the implications for thermal evolution of the Moon?



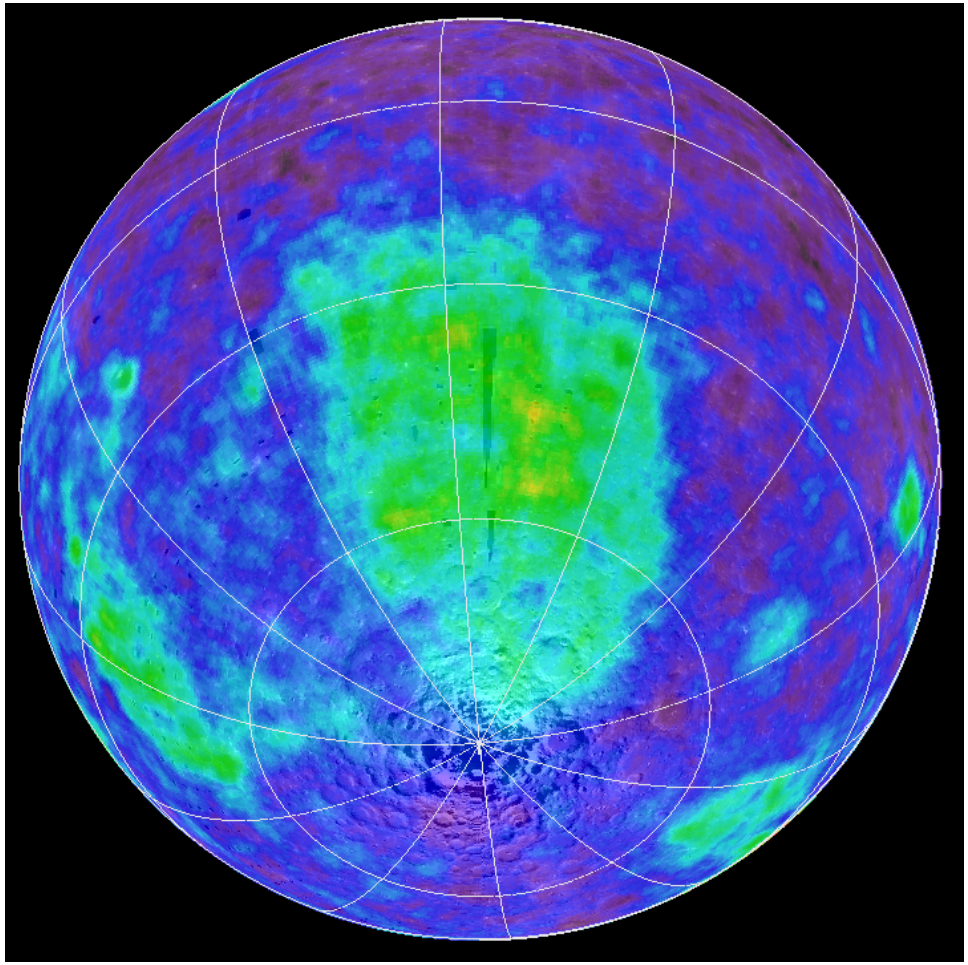


Iron Distribution

What is the source of the mafic signature?

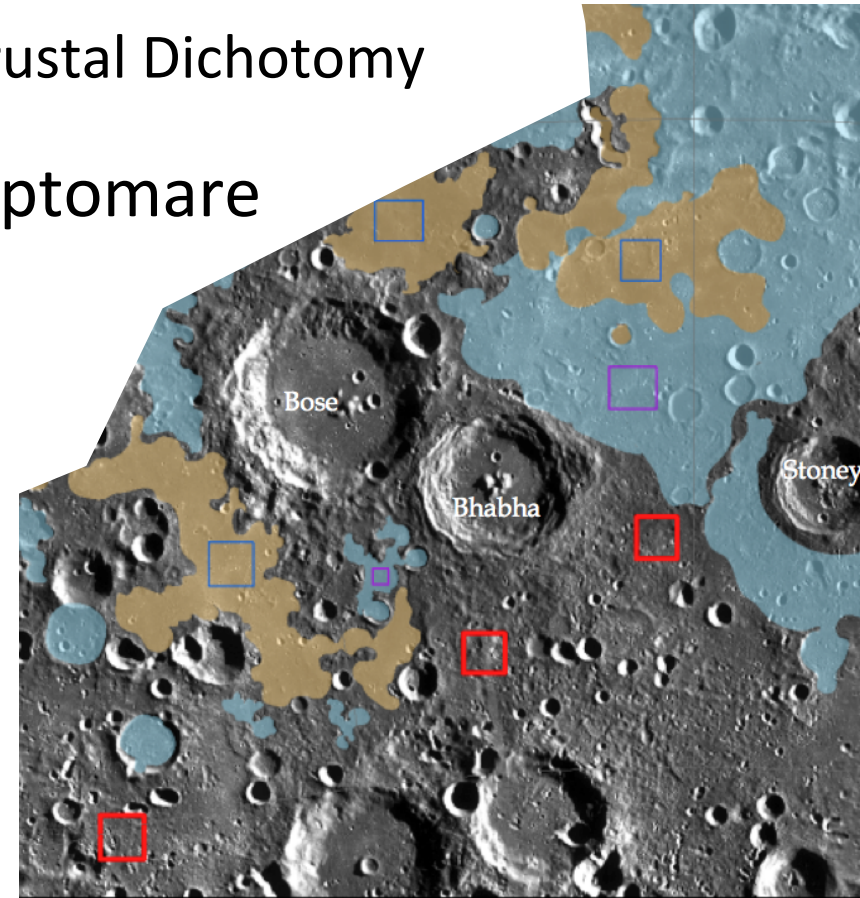
- Lower crust
- Upper mantle
- Mare/cryptomare

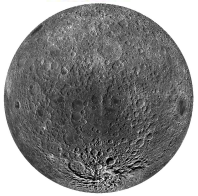
What lithologic components contribute to the compositional signature?



Sample Return Science Themes

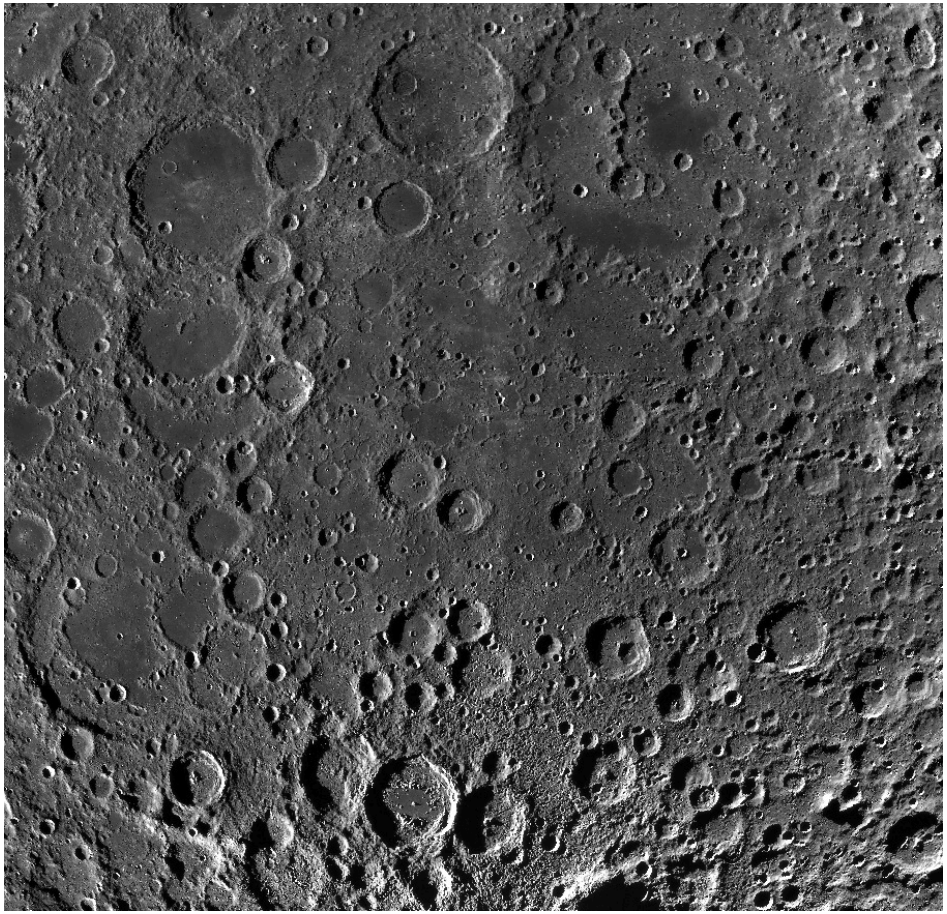
- Basin Chronology, Bombardment History
- Composition, Mineralogy of Lunar Interior
  - Lower Crust, Upper Mantle; Crustal Dichotomy
- Farside Basalts, including Cryptomare
- Intra Basin Plains Deposits
- Thorium/KREEP Distribution
- Magnetic Anomalies

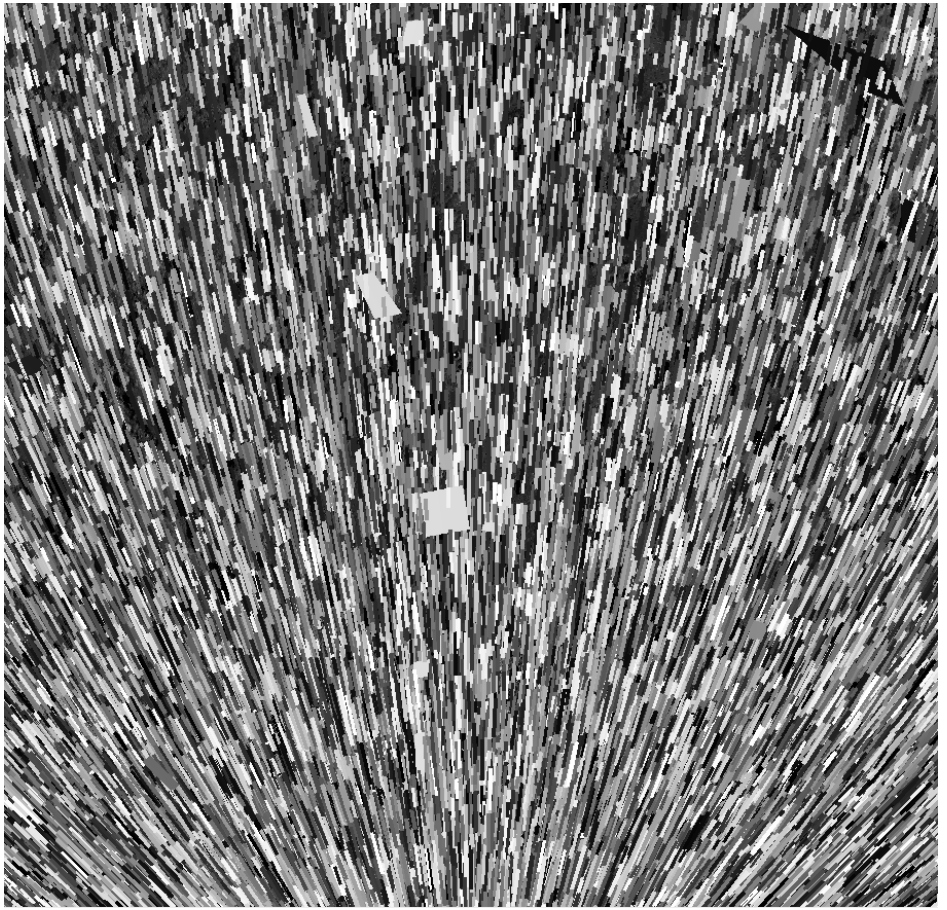




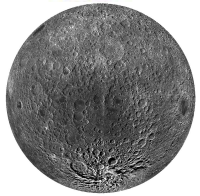
Existing NAC Coverage

Many individual images



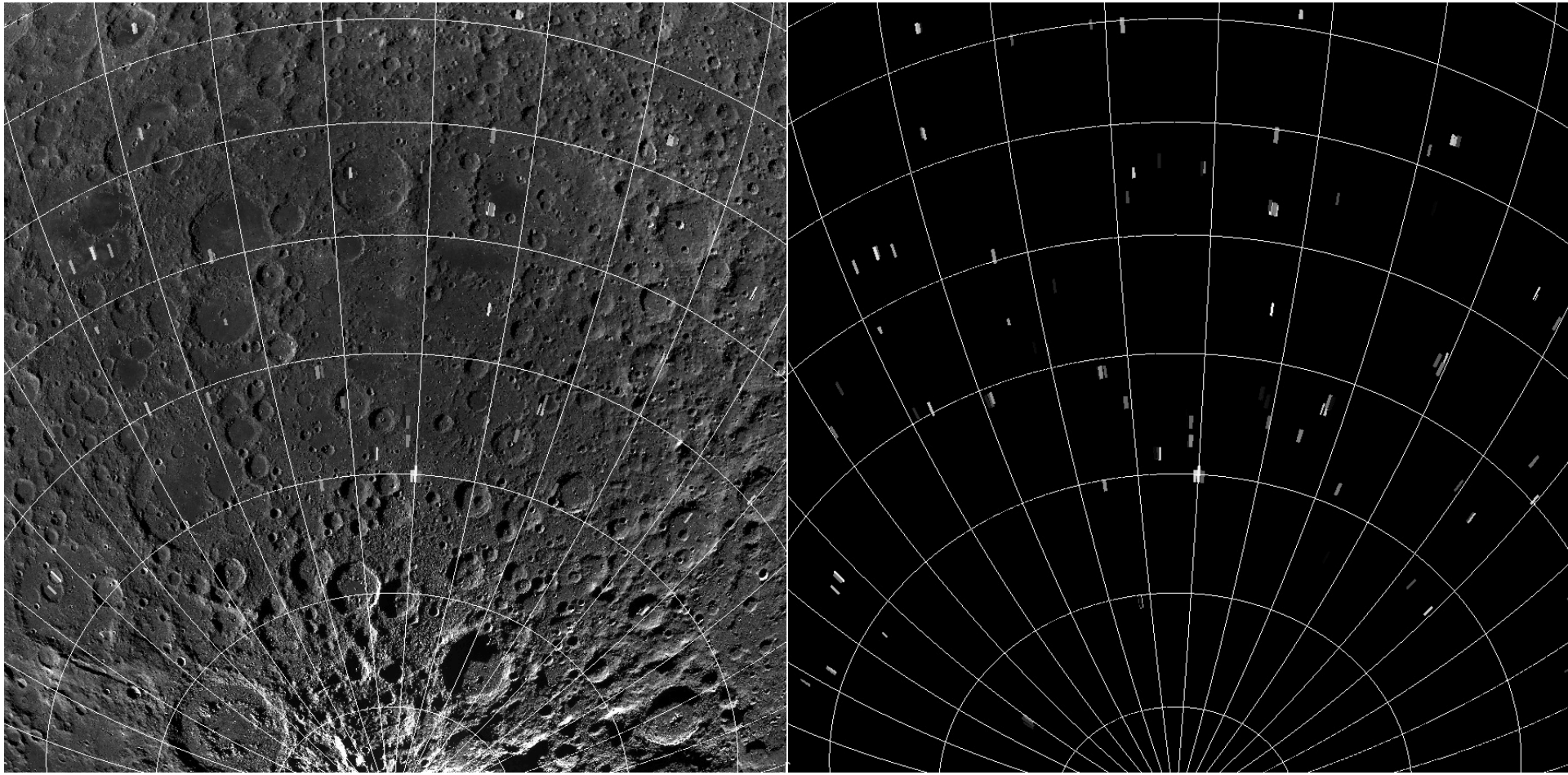


Coverage as of June 2012 PDS release



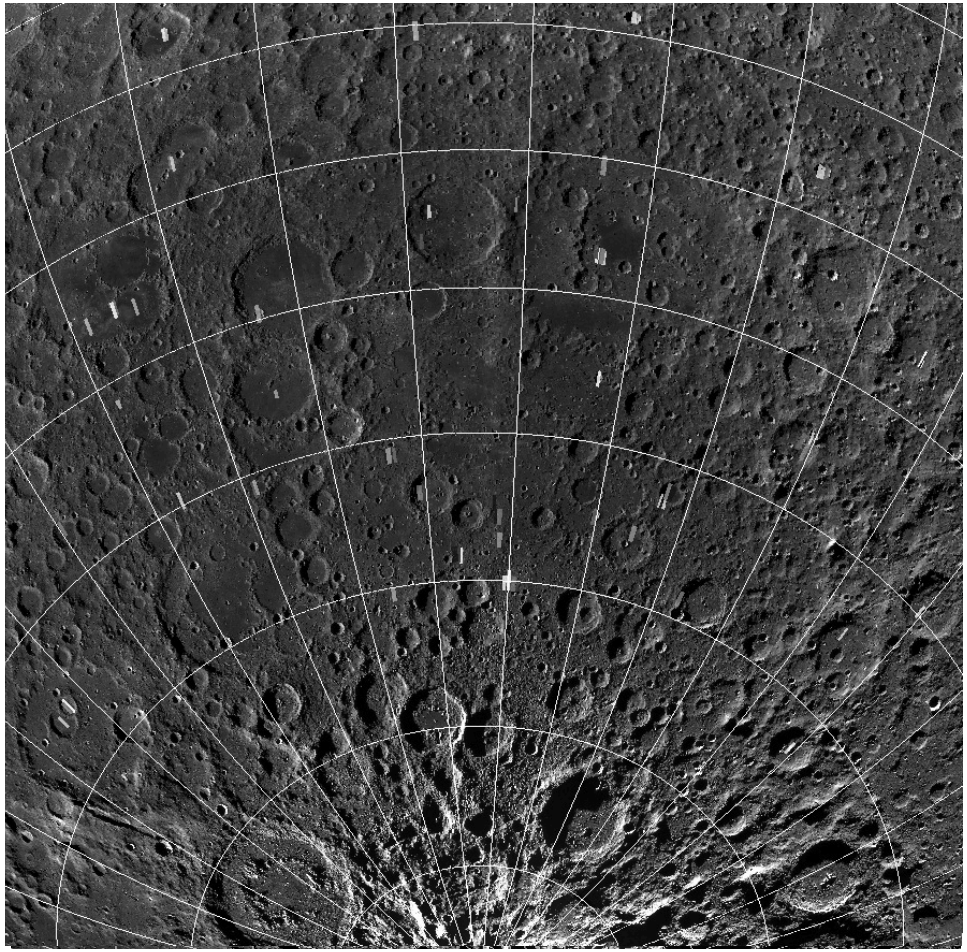
NAC Geometric Stereo

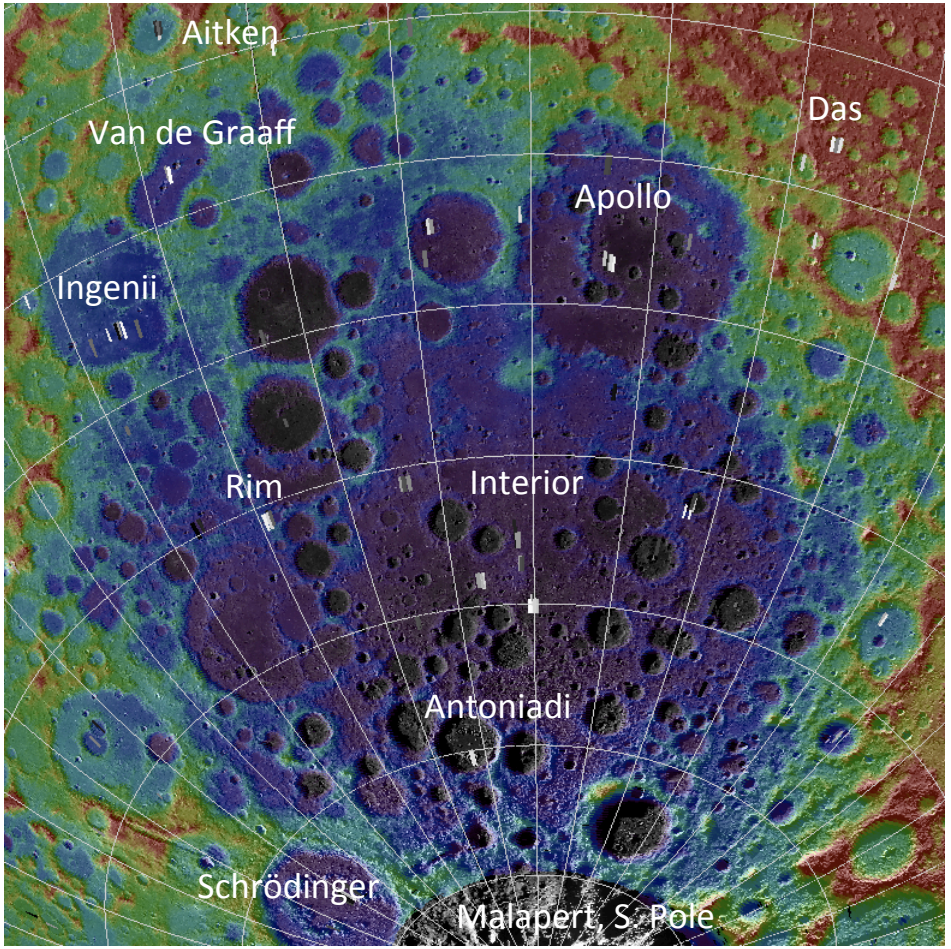
Not many geometric stereo images



As of June 2012

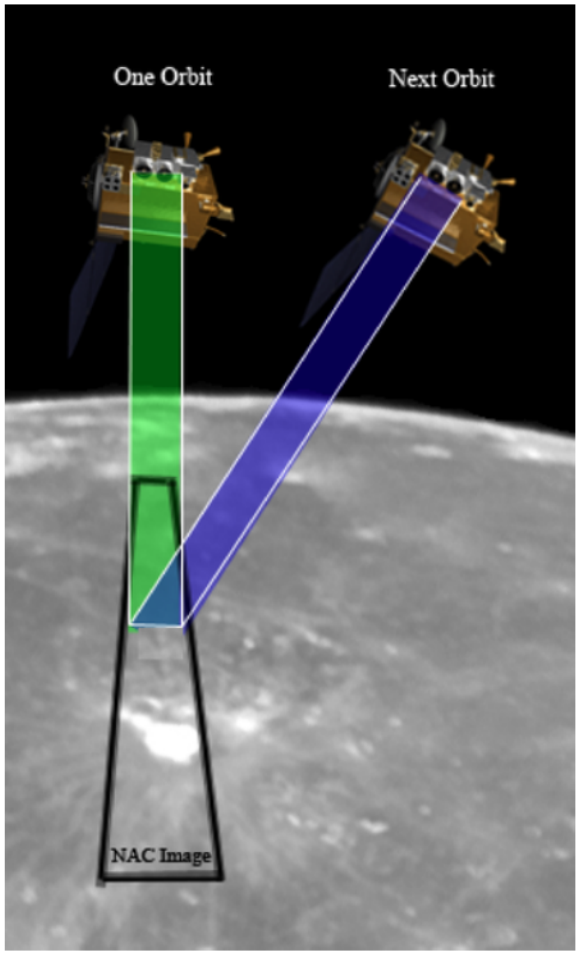
NAC Geometric Stereo





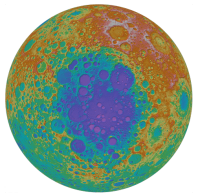
LROC Imaging for Geometric Stereo

- LROC NAC DTMs are made from geometric stereo pairs (two images of the same area on the ground, taken from different view angles under nearly the same illumination).
- LROC not designed as a stereo system, but can obtain stereo pairs through images acquired from two orbits - with at least one off-nadir slew.
- Off-nadir slews interfere with the data collection of other instruments, so LROC slew opportunities are limited.



Images for Geometric Stereo are Expensive

- **In the ESM, per year:**
  - Four months with illumination suitable for geometric stereo
  - Two stereo pairs per day
  - Max ~ 48 total pairs in SPA
- **For latitudes south of 60 degrees**
  - One month during each beta cycle available for geometric stereo
- **40-60 degrees incidence** is best for good geometric stereo solution
- **A geometric stereo NAC pair** covers only an area of about 5 x 25 km; for large areas use WAC GLD100 DEM
- ***NAC stereo images require a lot of resources.***



NAC DTMs

- LROC Web:

http://wms.lroc.asu.edu/lroc/dtm_select

- LMMP

http://pub.lmmp.nasa.gov/LMMPUI/LMMP_CLIENT/LMMP.html

- See also:

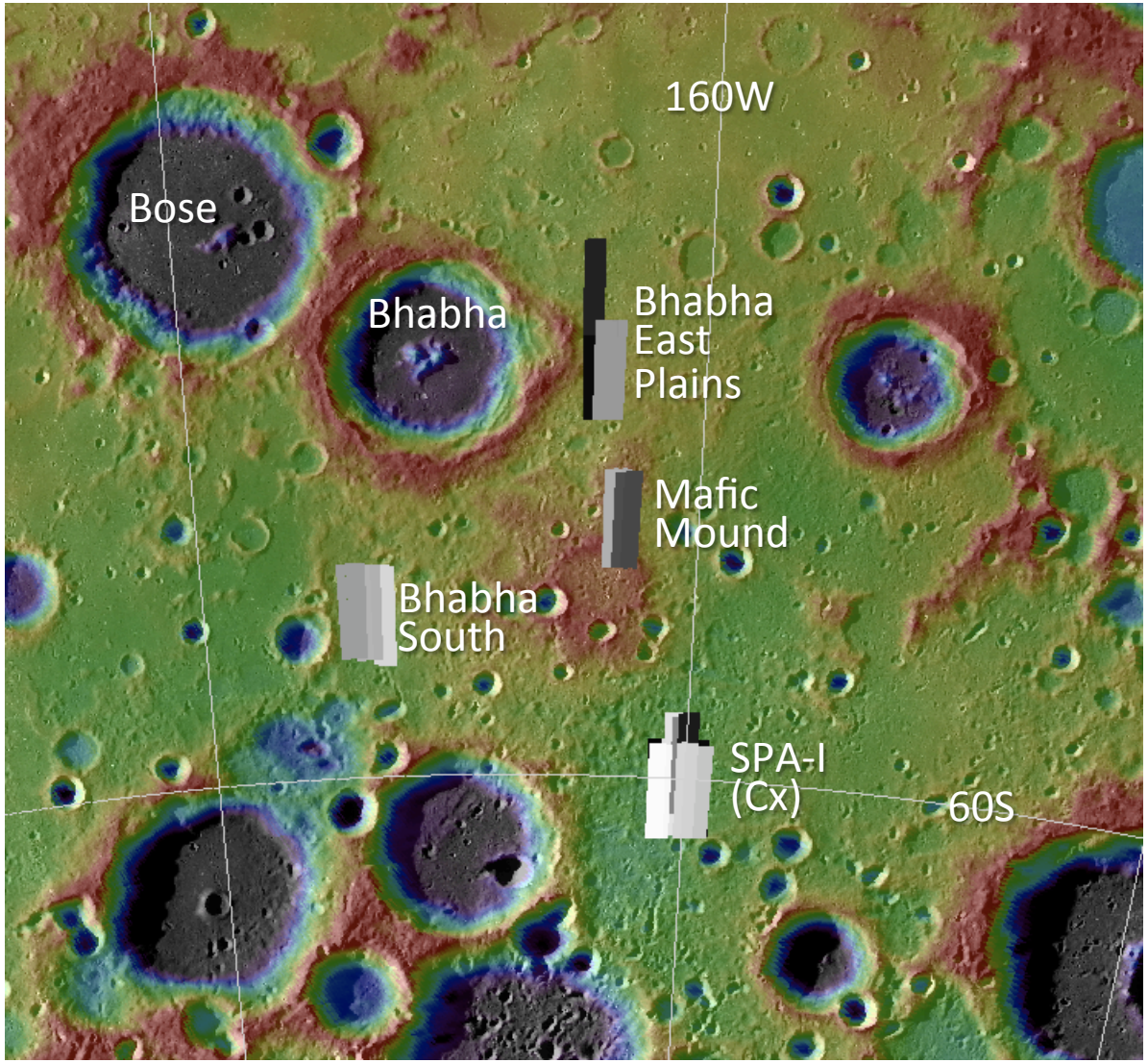
http://wms.lroc.asu.edu/lroc/dtm_about

http://www.asprs.org/a/publications/proceedings/orlando2010/files/Tran.pdf

Rosiek et al. (2012) USGS digital terrain models and mosaics for LMMP. *43rd Lunar Planet. Sci. Conf.*, #2343.

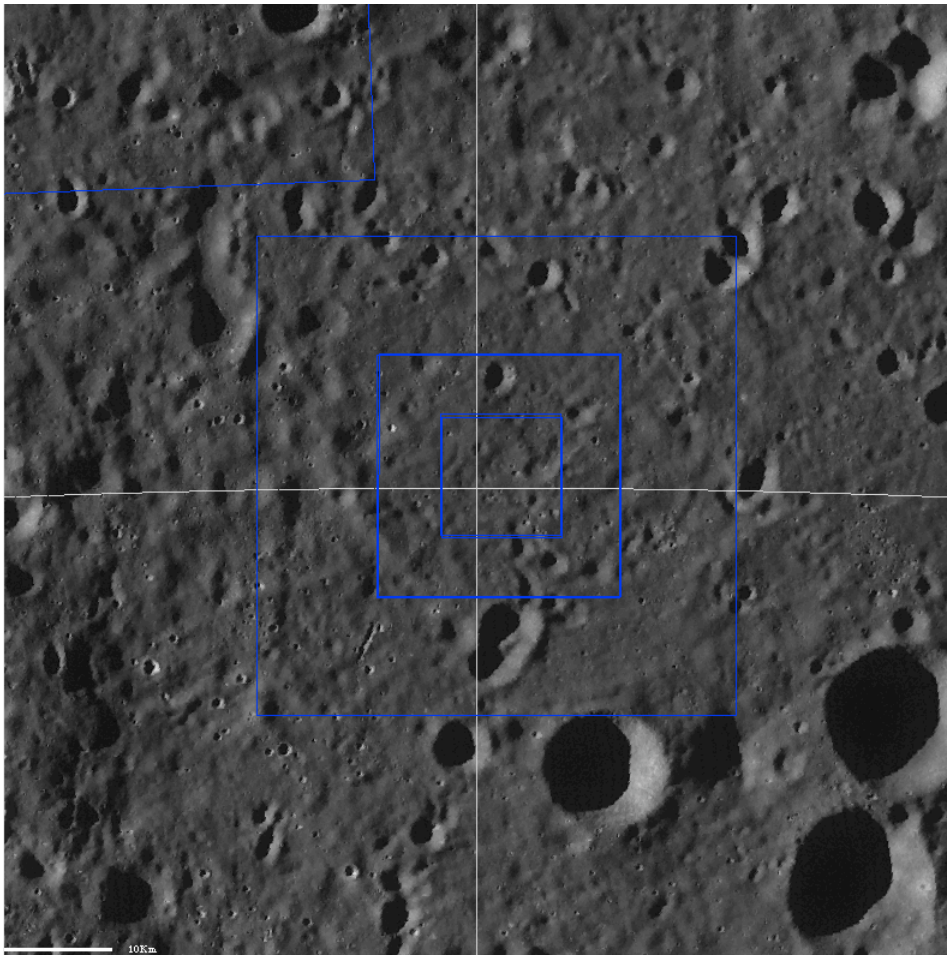
Mattson et al. (2012) Regional digital terrain model production with LROC-NAC. *43rd Lunar Planet. Sci. Conf.*, #2630.

SPA-Interior

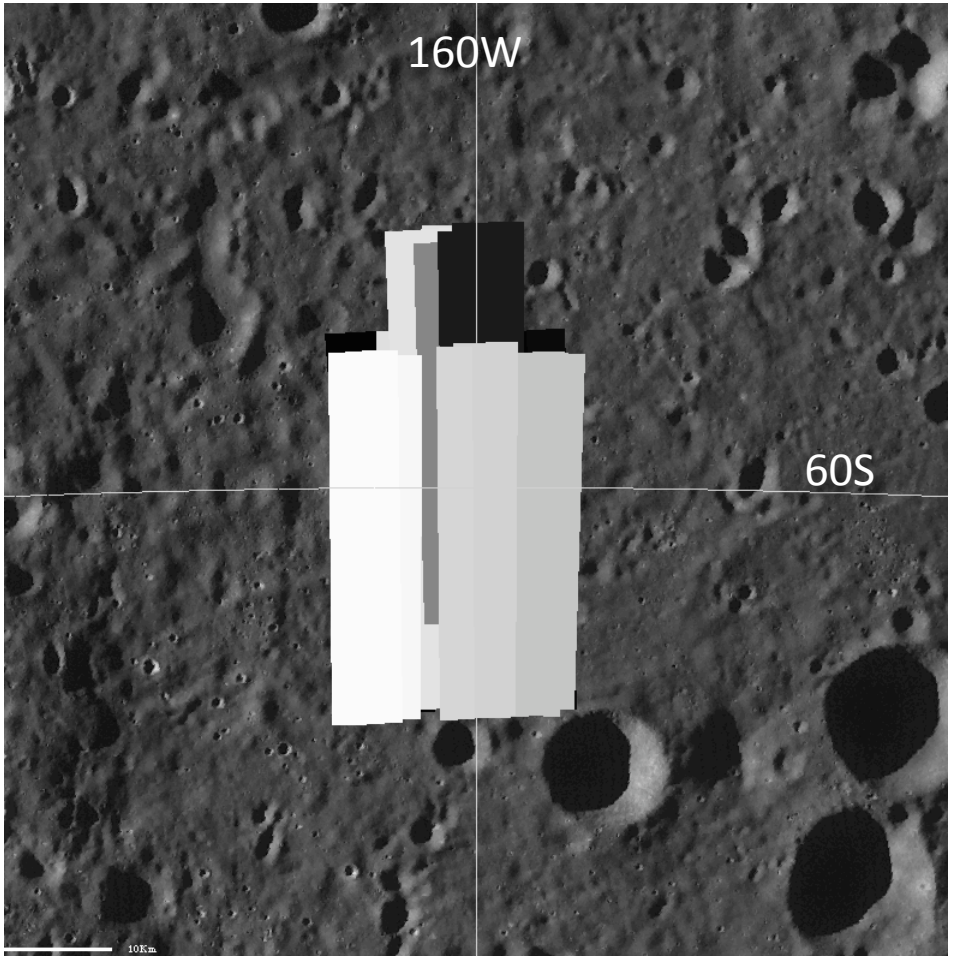


SPA Interior (Cx)

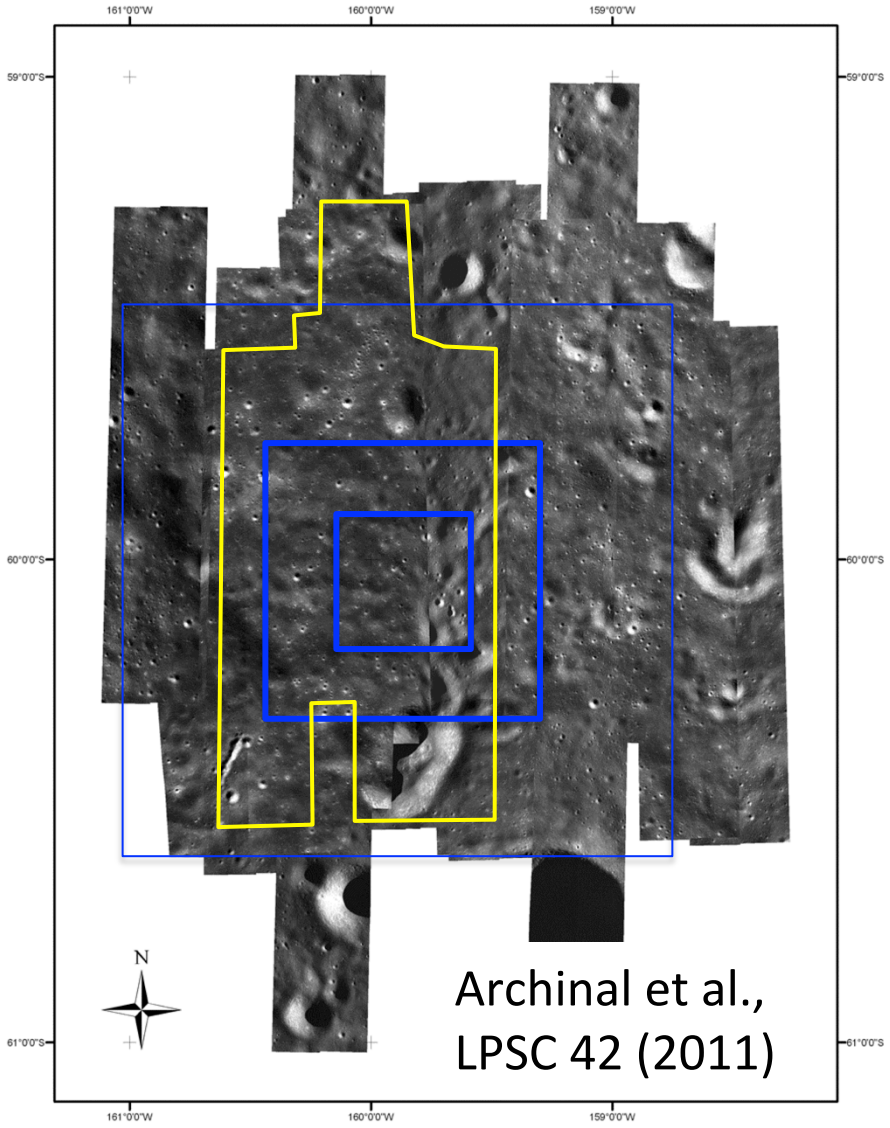
Constellation ROIs



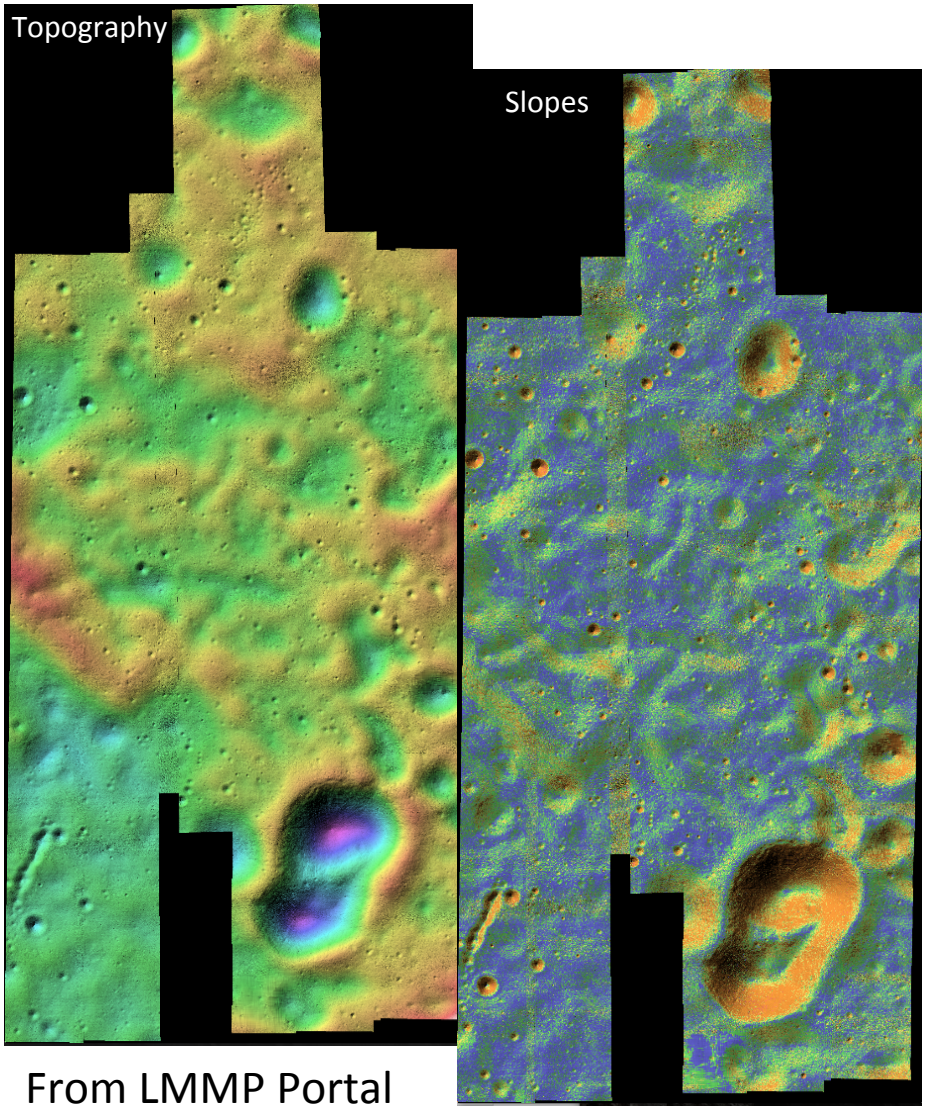
NAC Stereo Coverage



SPA Interior (Cx)



Archinal et al., LPSC 42 (2011)



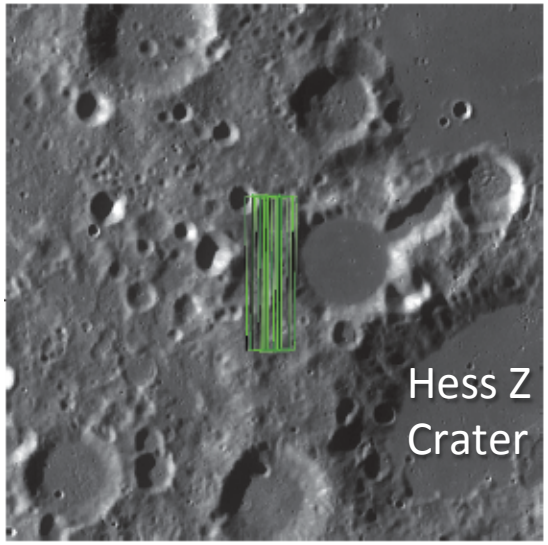
From LMMP Portal

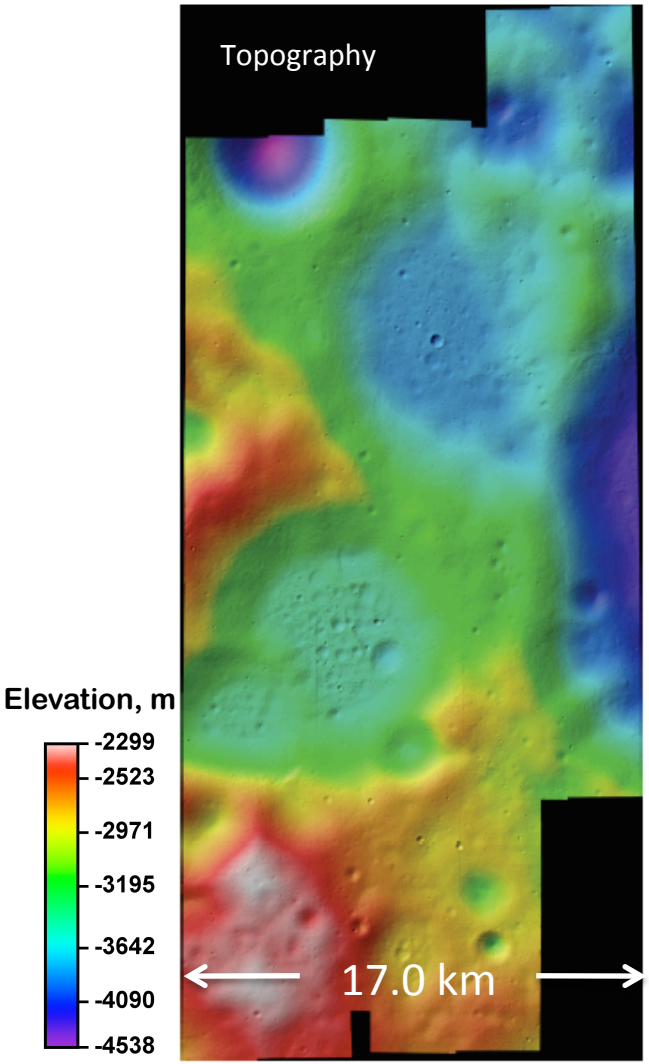
PROGRESS ON HIGH RESOLUTION MAPPING OF THE LUNAR SOUTH POLE-AITKEN BASIN INTERIOR. B. Archinal[1], L. Gaddis[1], T. Hare[1], M. Rosiek[1], E. Howington-Kraus[1], E. Lee[1], L. Weller[1], R. Kirk[1],

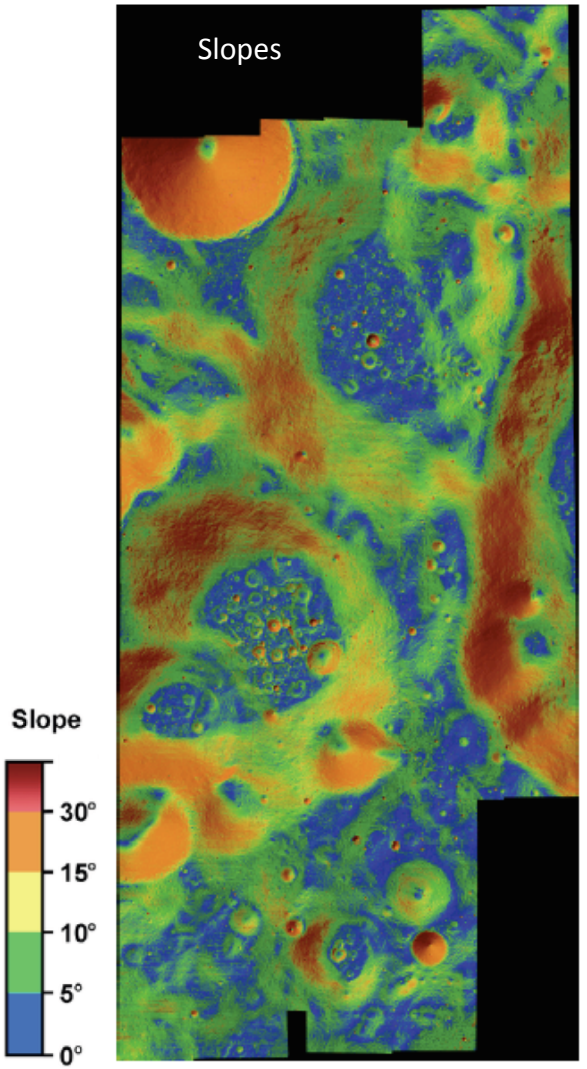
SPA-Rim (Cx)

SPA Rim
Constellation site

Center Lat: 51°S
Center Lon: 171°E





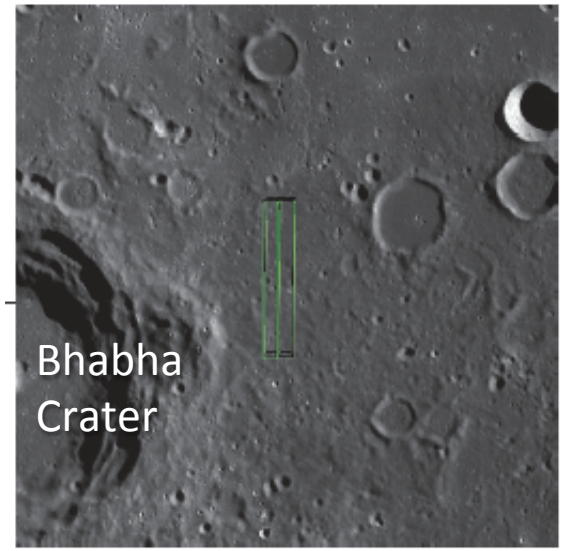


LMMP Portal, DTM by ASU

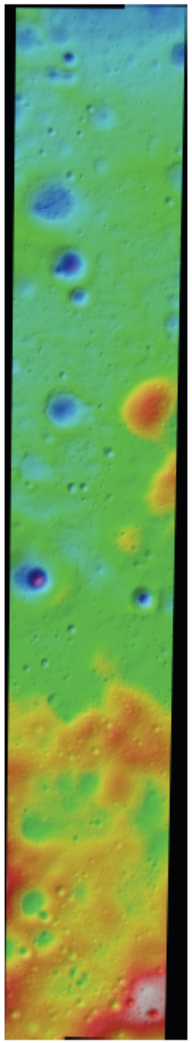
SPA Interior, Bhabha East

Bhabha East Plains

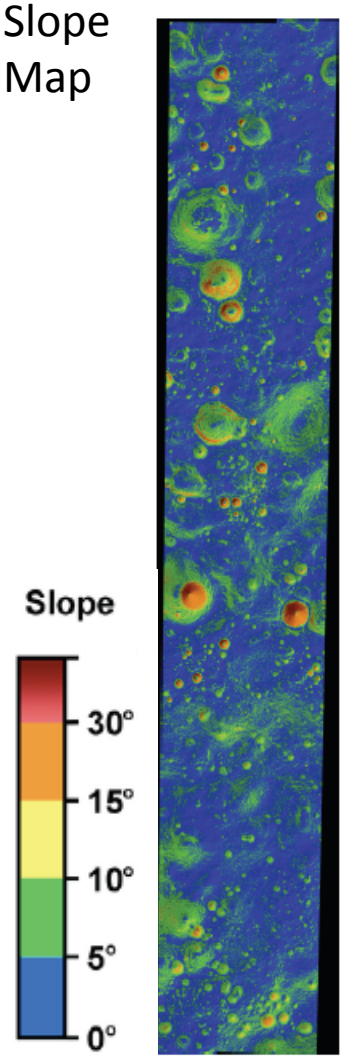
Center Lat: 55°S
Center Lon: 198°E



Color Shaded Relief Map



Slope Map



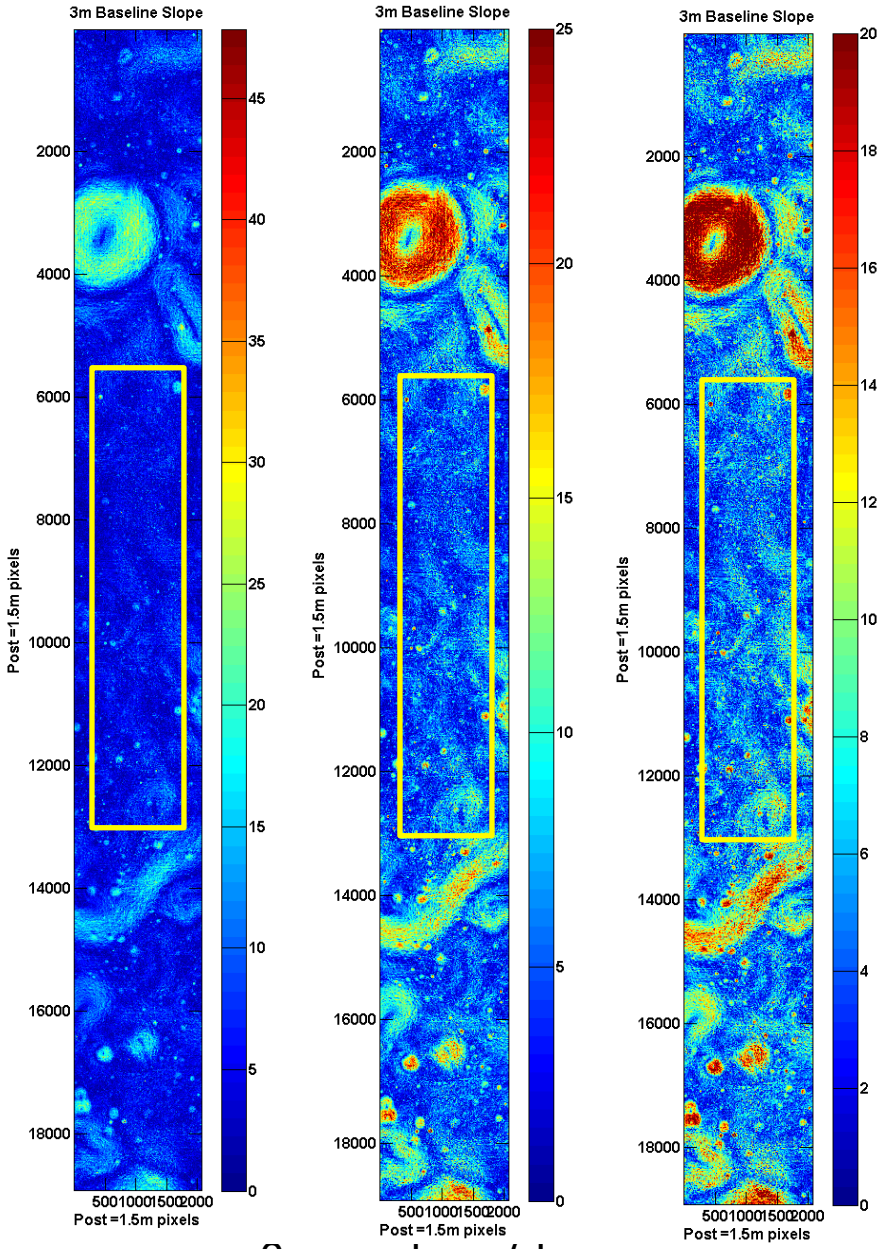
ASU

Landing Site Analysis

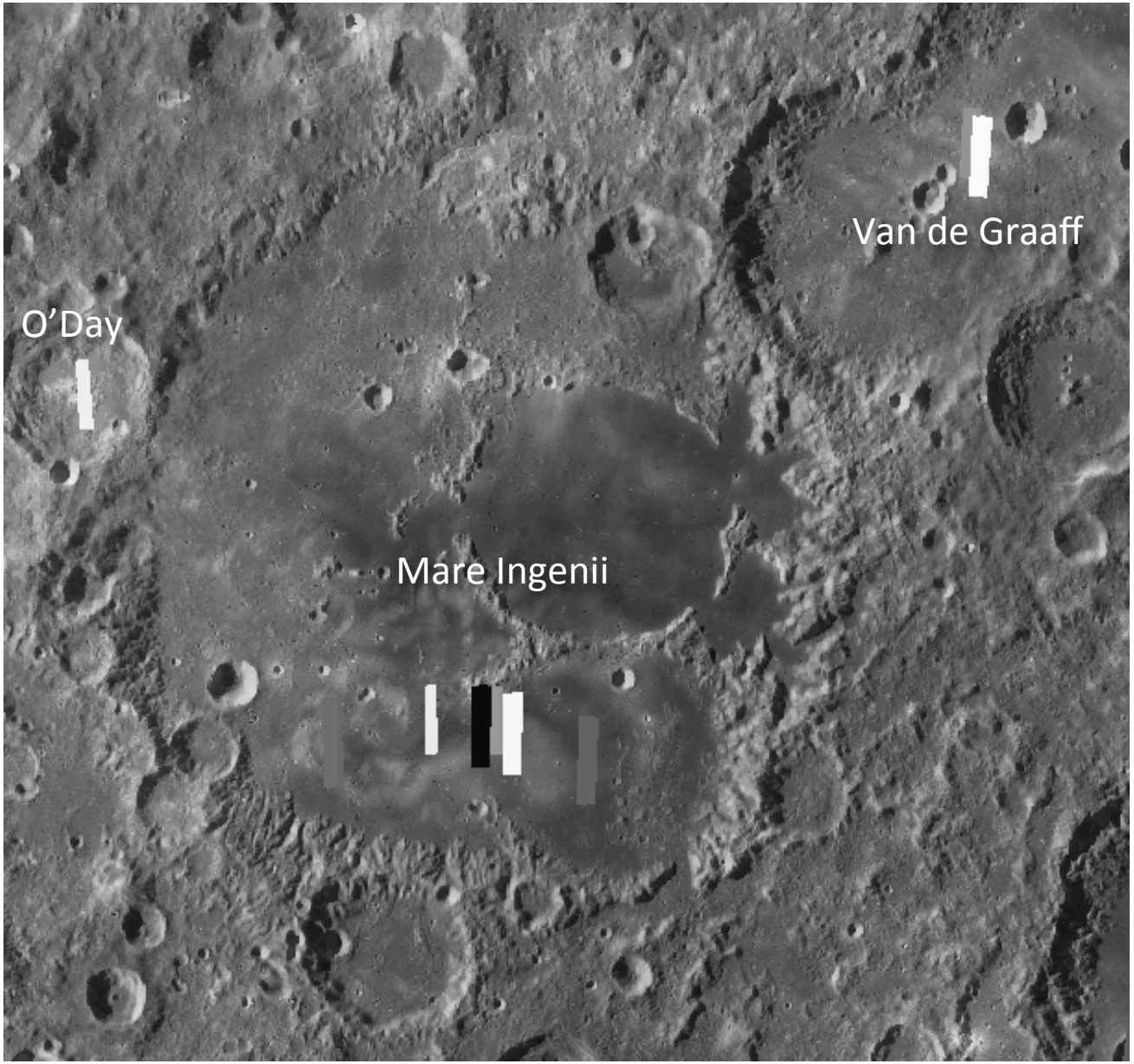
Slope and Roughness Analysis (NAC DEM)

DEM Posts: 1.5 m
Finest scale slope: 3 m

Can stretch to bring out detail (see area in yellow box)



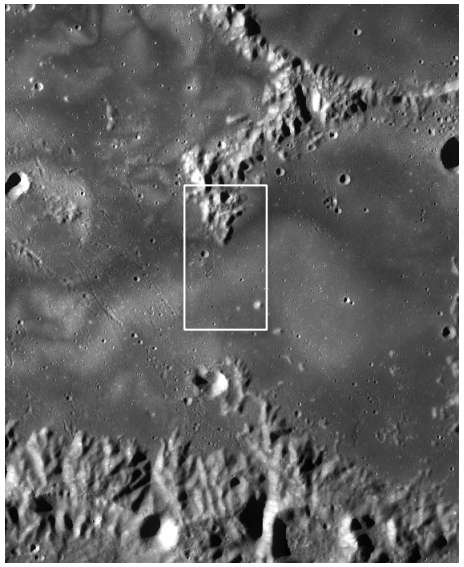
Mare Ingenii and Van de Graaff Crater

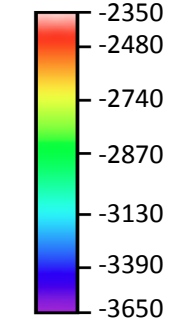


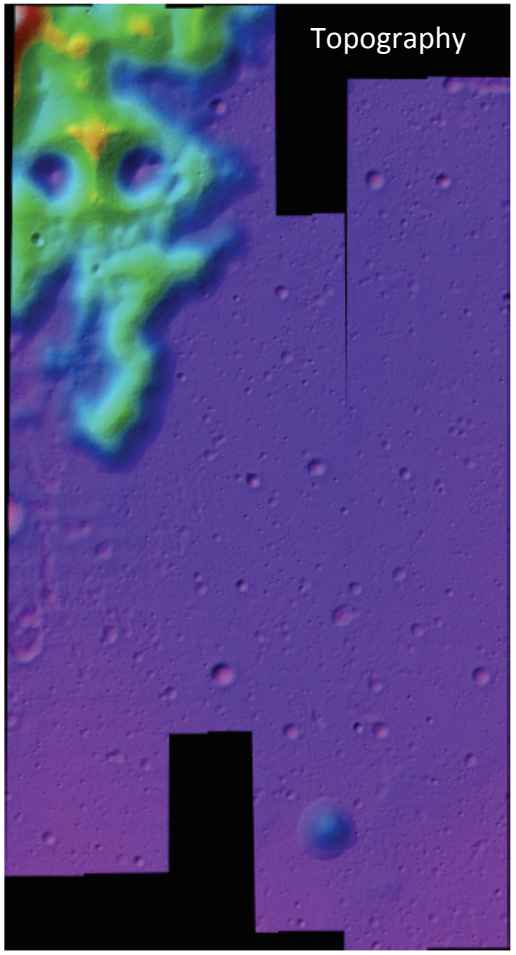
Mare Ingenii

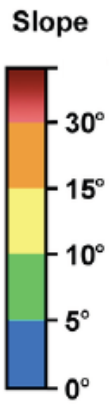
Mare Ingenii

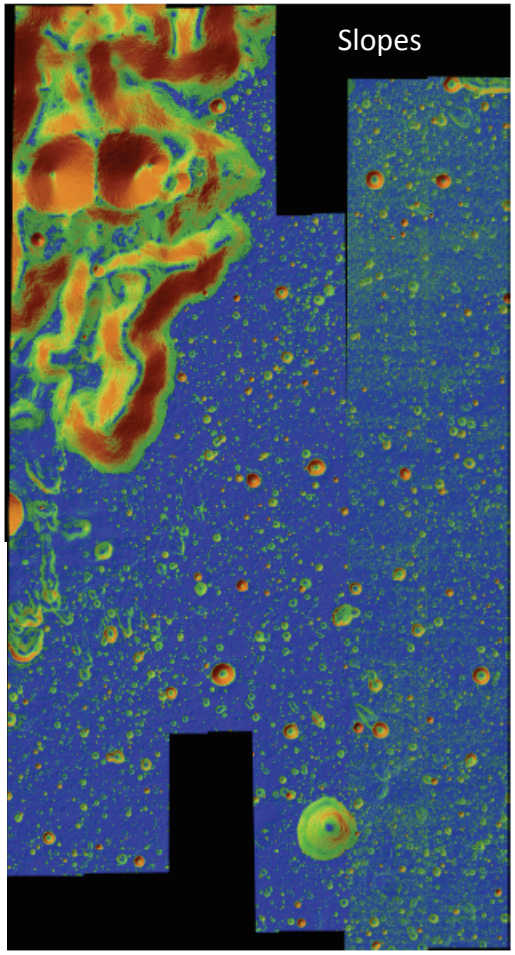
Center Lat: 35°S
Center Lon: 164°E



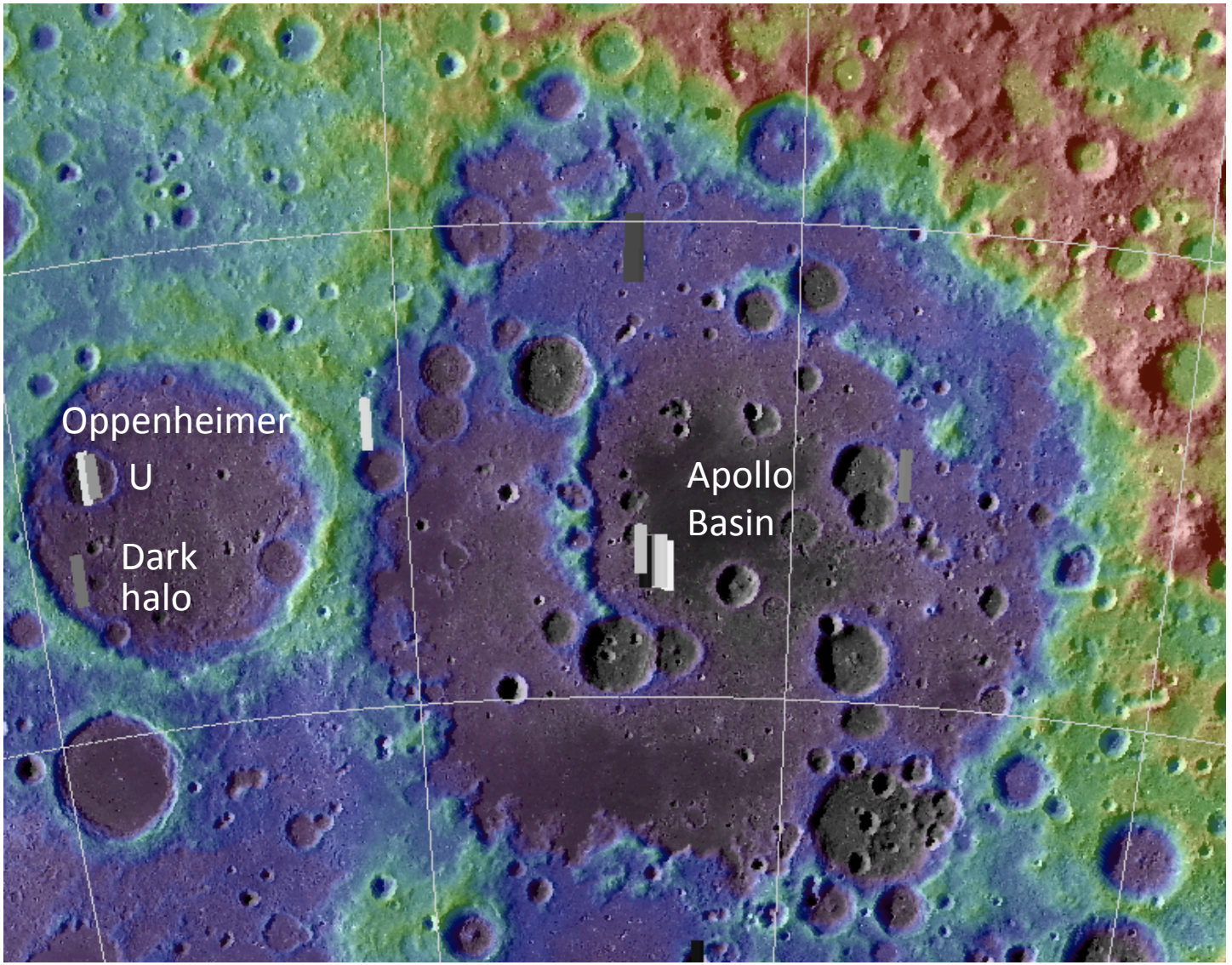






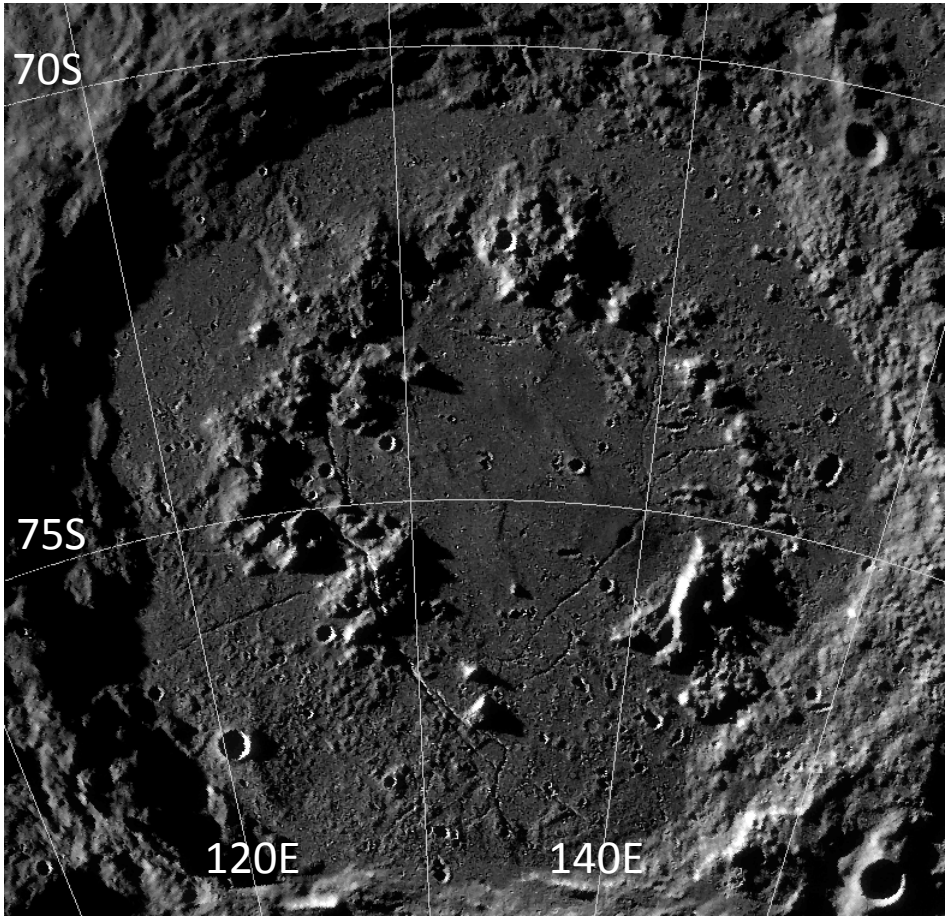


Apollo Basin and Oppenheimer Crater

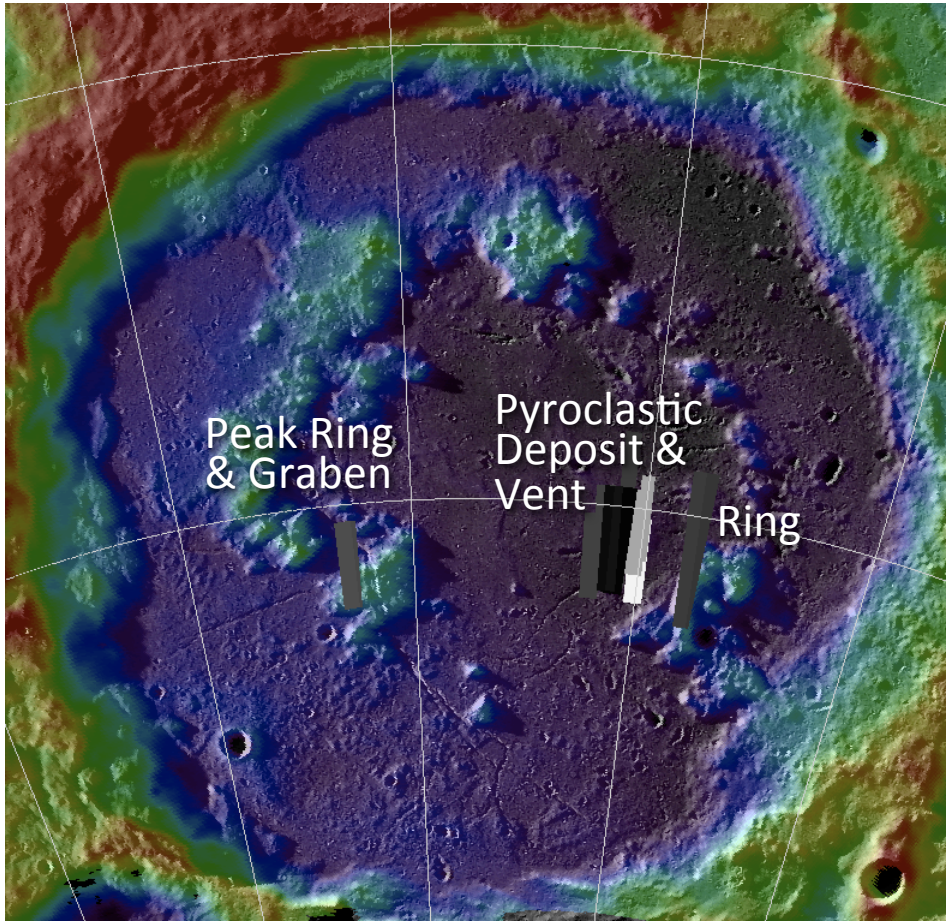


WAC GLD100

Schrödinger Basin

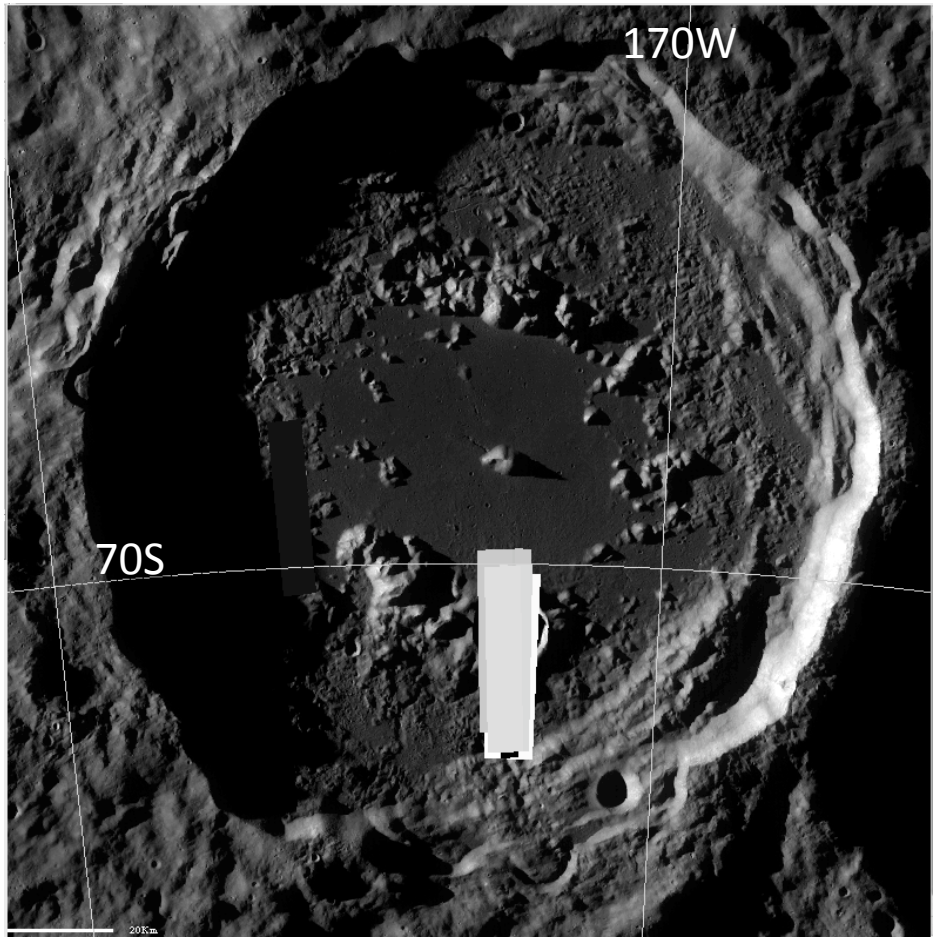


WAC Global

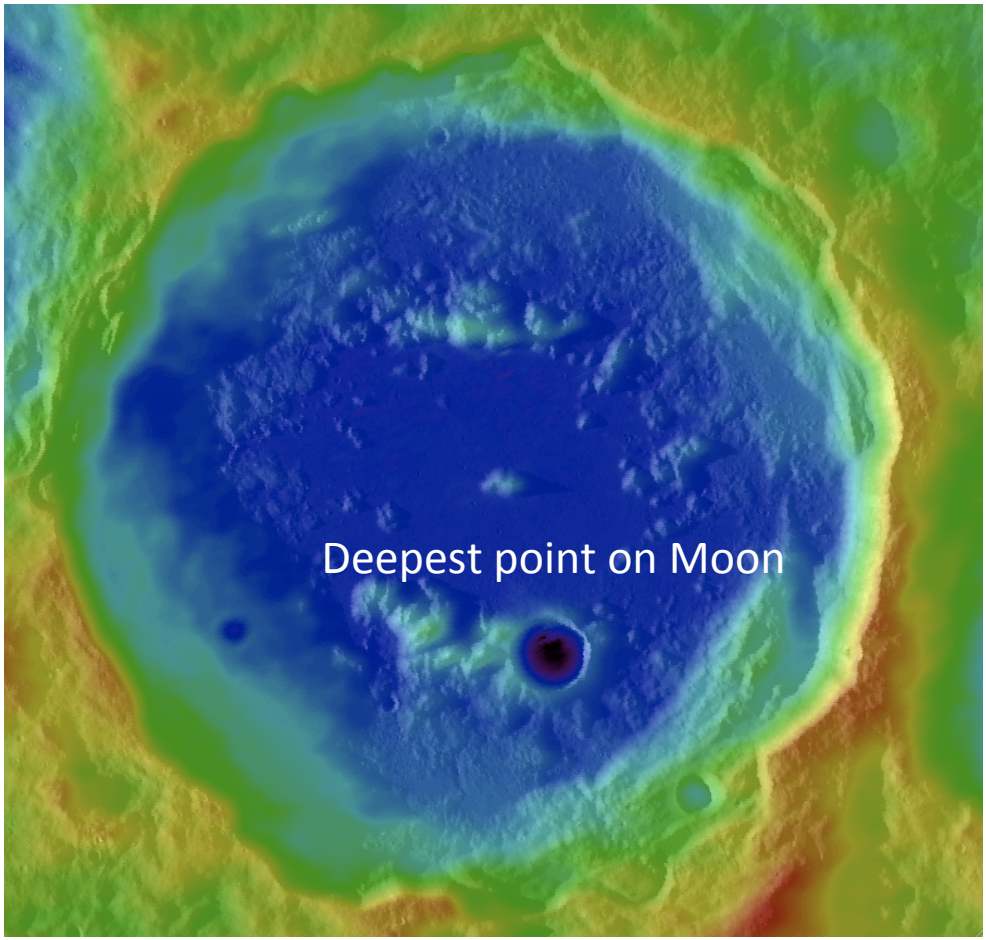


WAC GLD100

Antoniadi Crater



WAC Global



WAC GLD100

Plans for ESM Targeted Observations in SPA

- Fill NAC gaps
- Geometric stereo for key targets
- Science Community Input

- For geometric stereo image requests, contact Noah Petro (GSFC) (or Brad Jolliff)

noah.e.petro@nasa.gov blj@wustl.edu

- Include site coordinates; WAC base image to show extents; Science & exploration rationale. 1-2 page write-up

As soon as possible – LRO is currently in good illumination for SPA geometric stereo; no later than LEAG meeting, Oct. 22-24, 2012.